

# Examining the role of extreme rainfall in runoff generation and phosphorus loss from a headwater agricultural basin

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## **Cross ~ Border Workshop**

Adaptation to Climate Change:  
Information and Tools for  
Decision-Making

**Tuesday, October 17, 2017**

*11:45 AM to 12:00 PM*

Holiday Inn Syracuse/Liverpool

Syracuse, NY

# Annual P export is a function of storm size

WE-38 watershed  
Klingerstown, PA



July, 2011



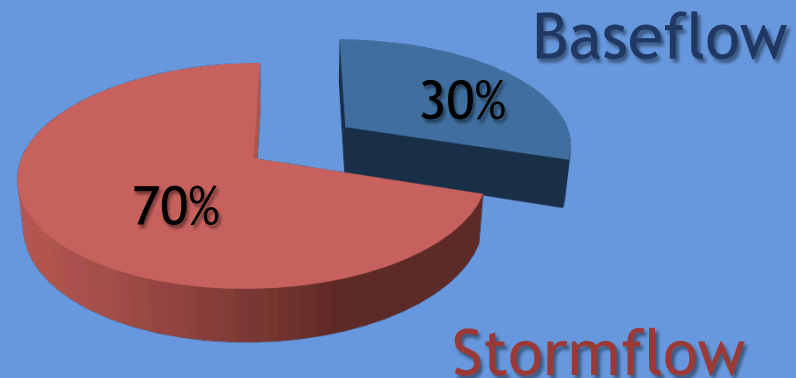
Baseflow – 90% of flows

September, 2011  
Flooding from Tropical Storm Lee



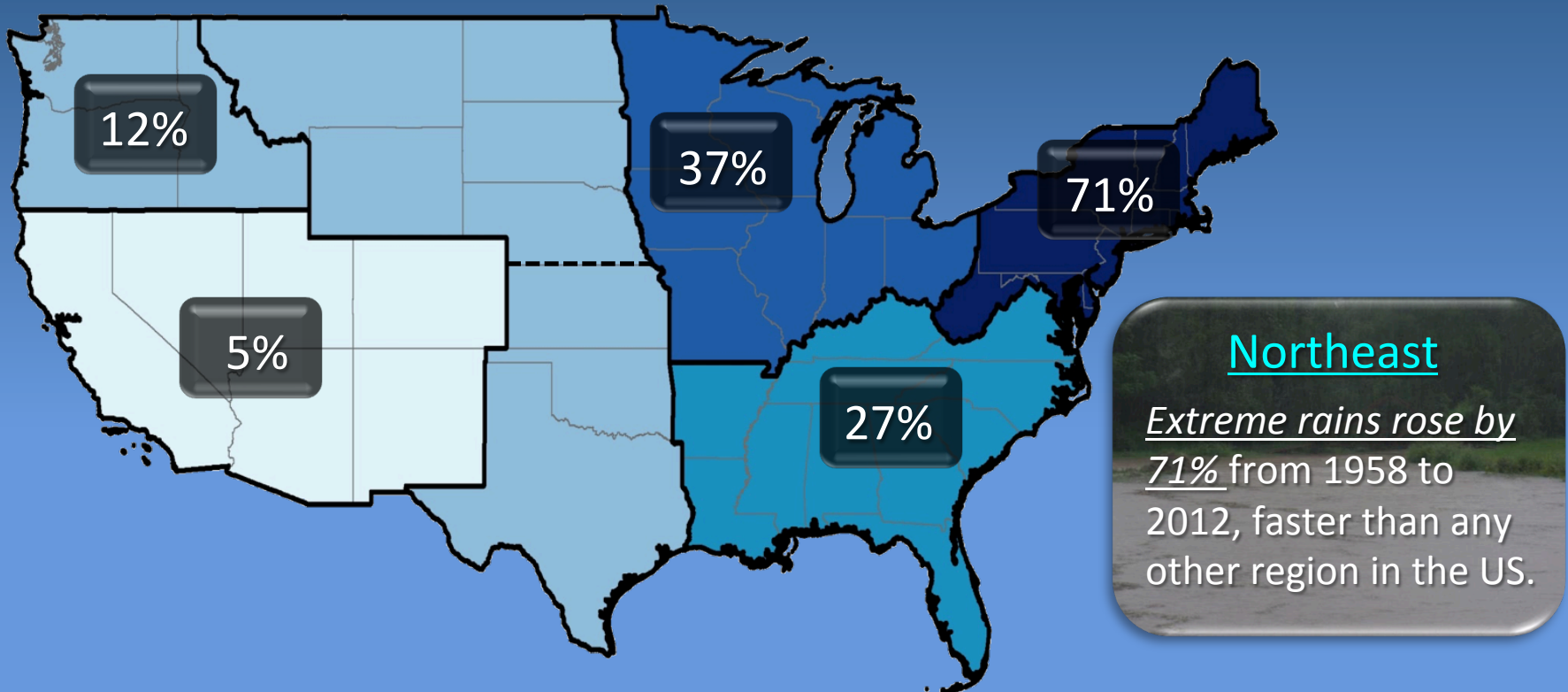
Stormflow – 10% of flows

Annual P export

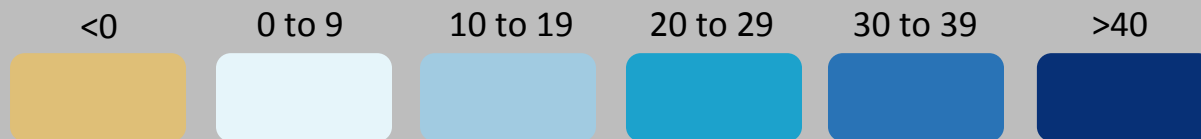


# The character of large storms is changing

*especially in the Northeastern United States*



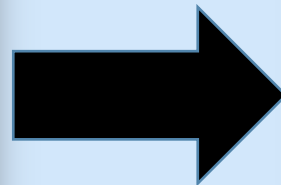
Percent change in extreme rainfall (heaviest 1% of daily events)



# Maximum daily rainfall is rising in the fall

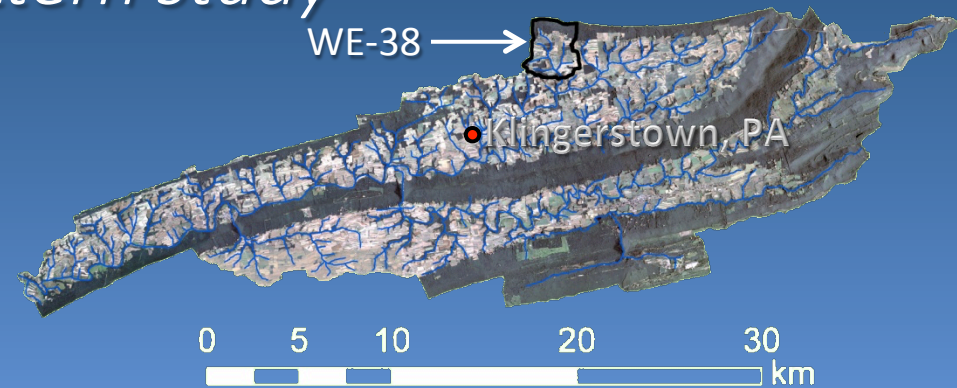
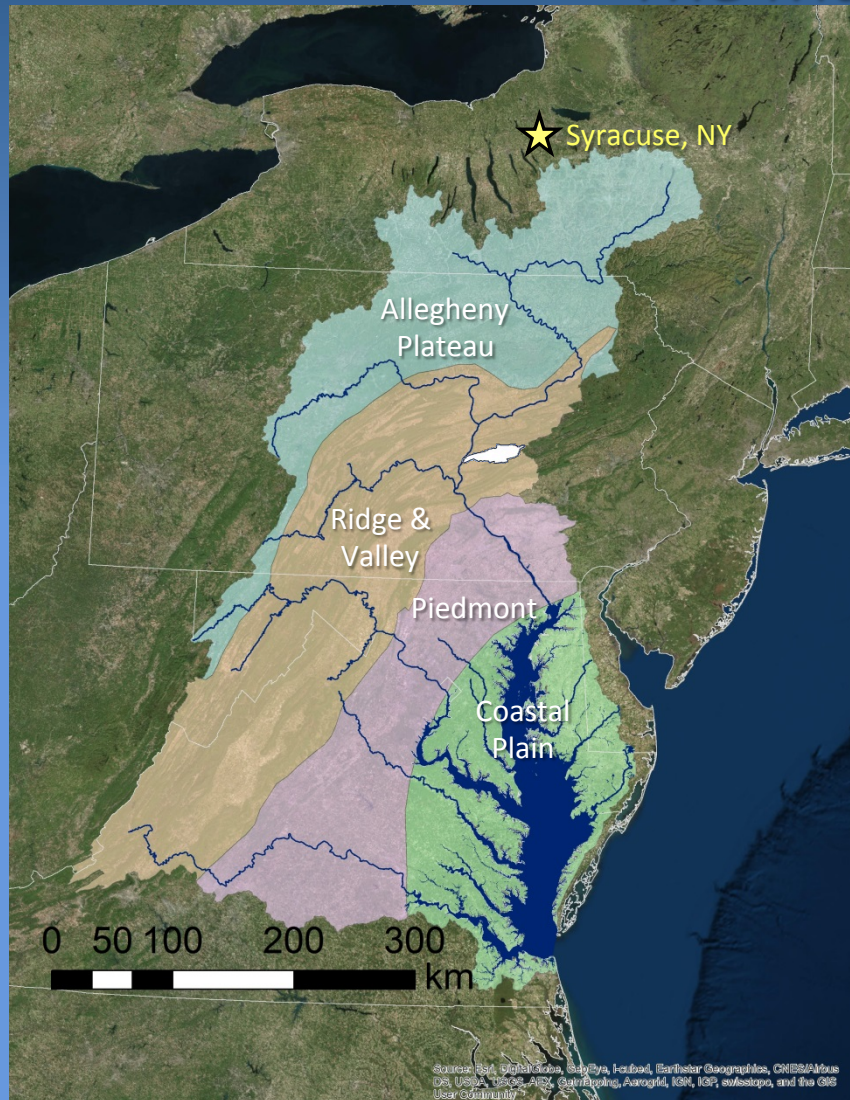
*In WE-38, the trend is significant from 1968 through 2012*

What is the role of extreme rainfall in runoff generation and P loss from small basins?



# Quantifying P losses in watershed runoff

## *The Mattern study*



WE-38 Watershed (7.3 km<sup>2</sup>)



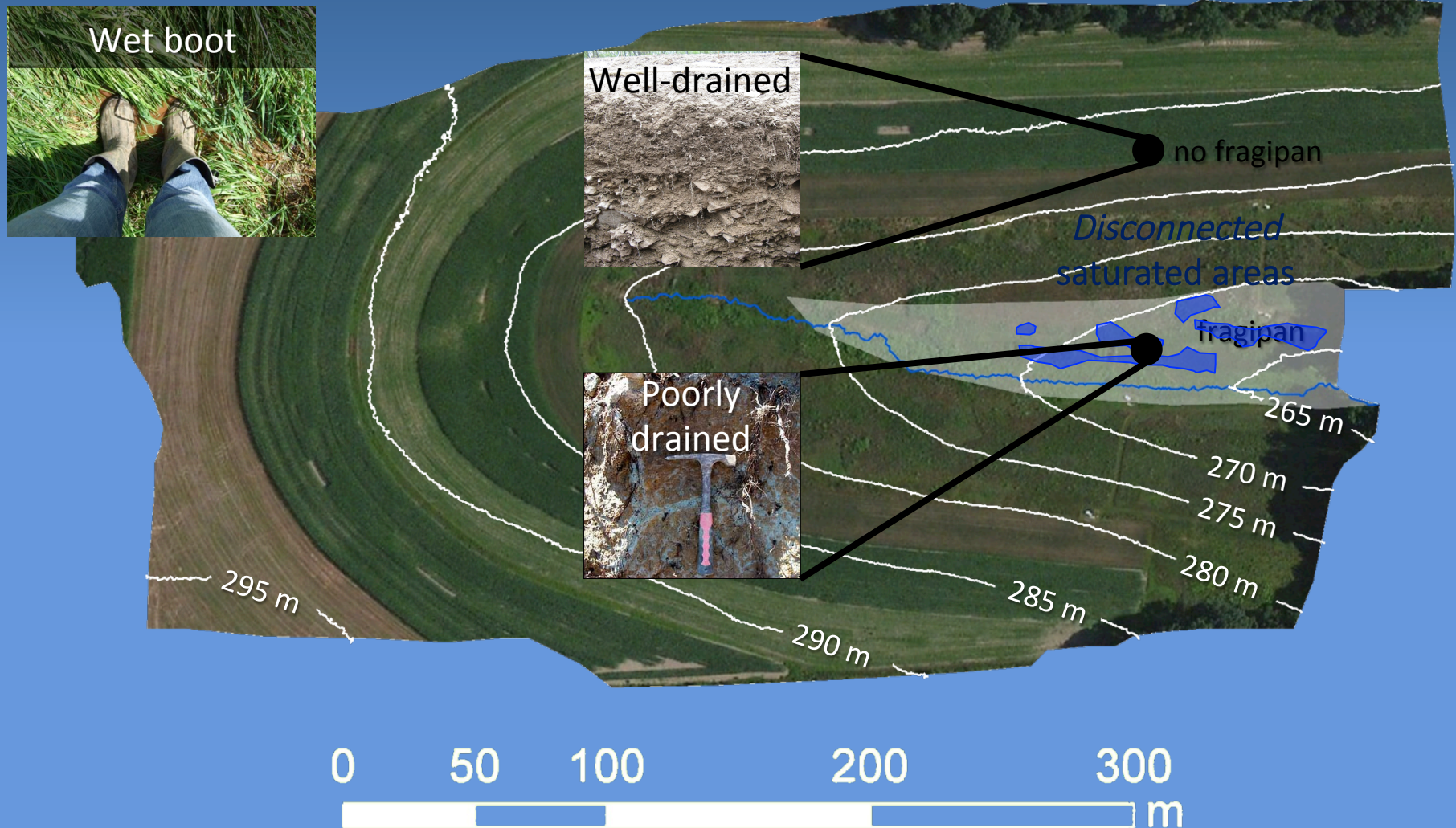
# The Mattern watershed

*An 11-ha headwater agricultural basin*



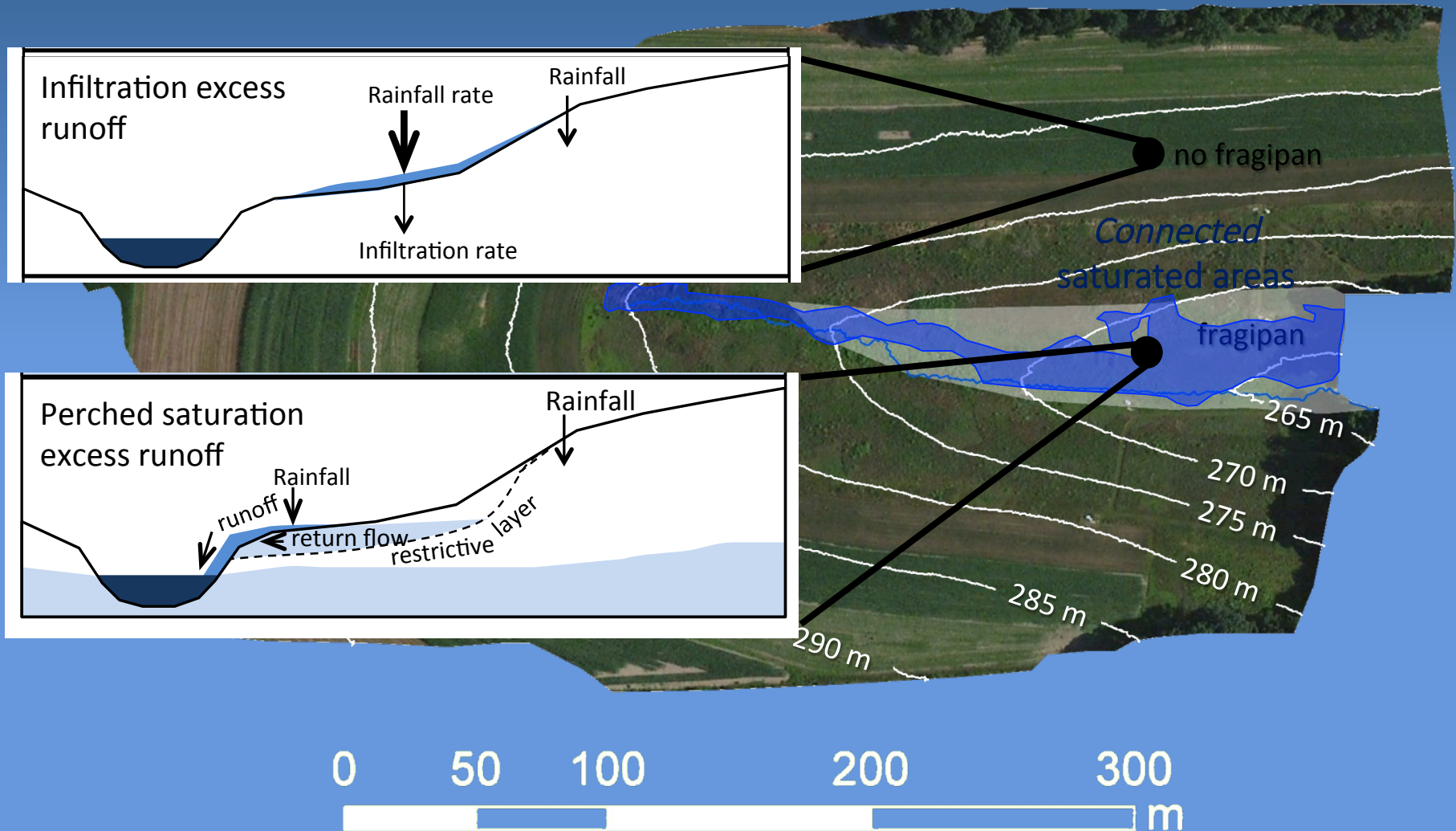
# Fragipan soils and saturated areas

*disconnected saturated areas under dry conditions*



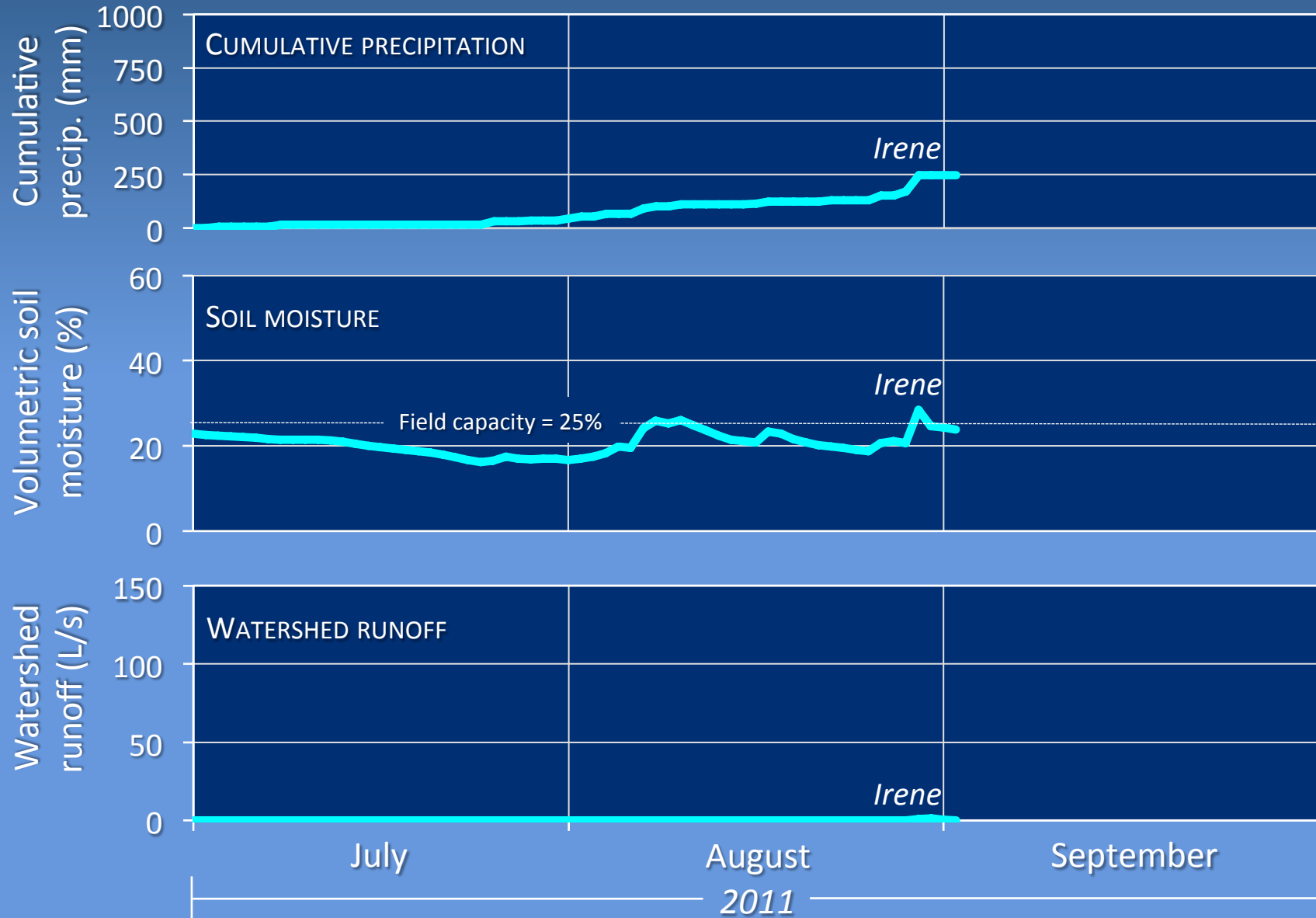
# Fragipan soils and runoff generation

*connected saturated areas enhance runoff generation*



# Setting the stage for Tropical Storm Lee

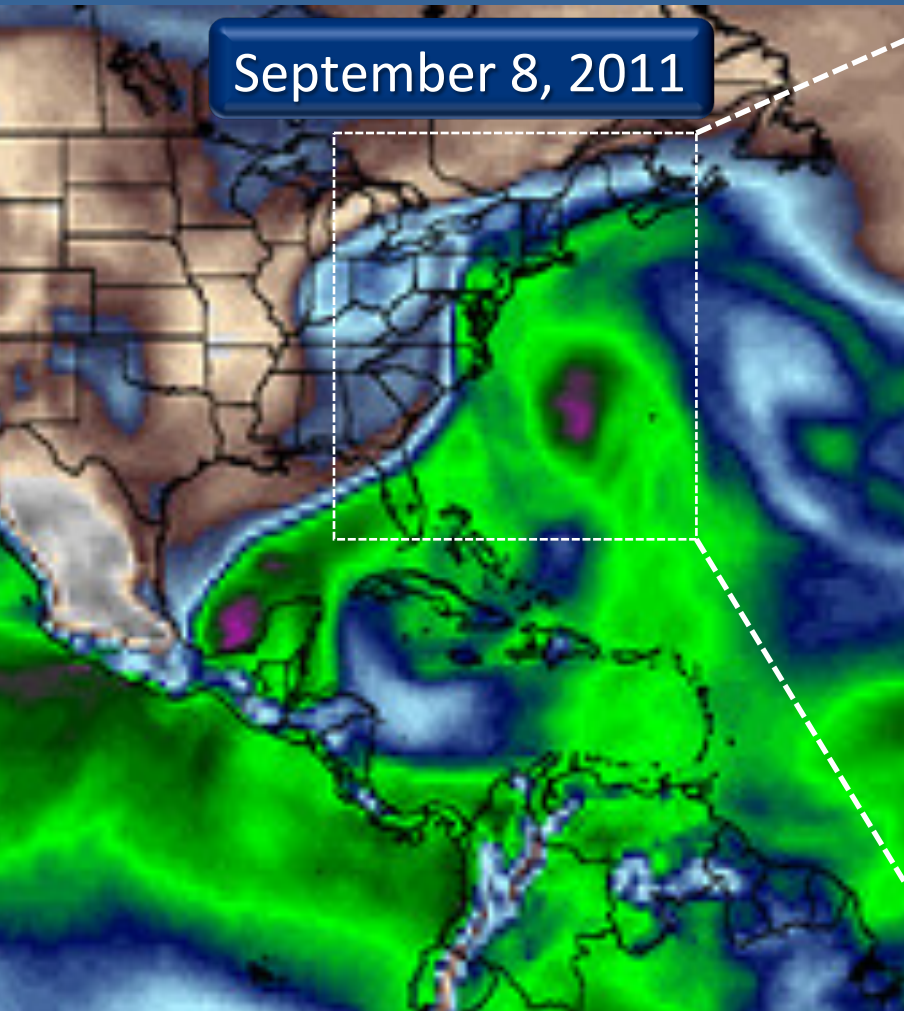
*Dry conditions prevailed until Irene delivered 116 mm of rain*



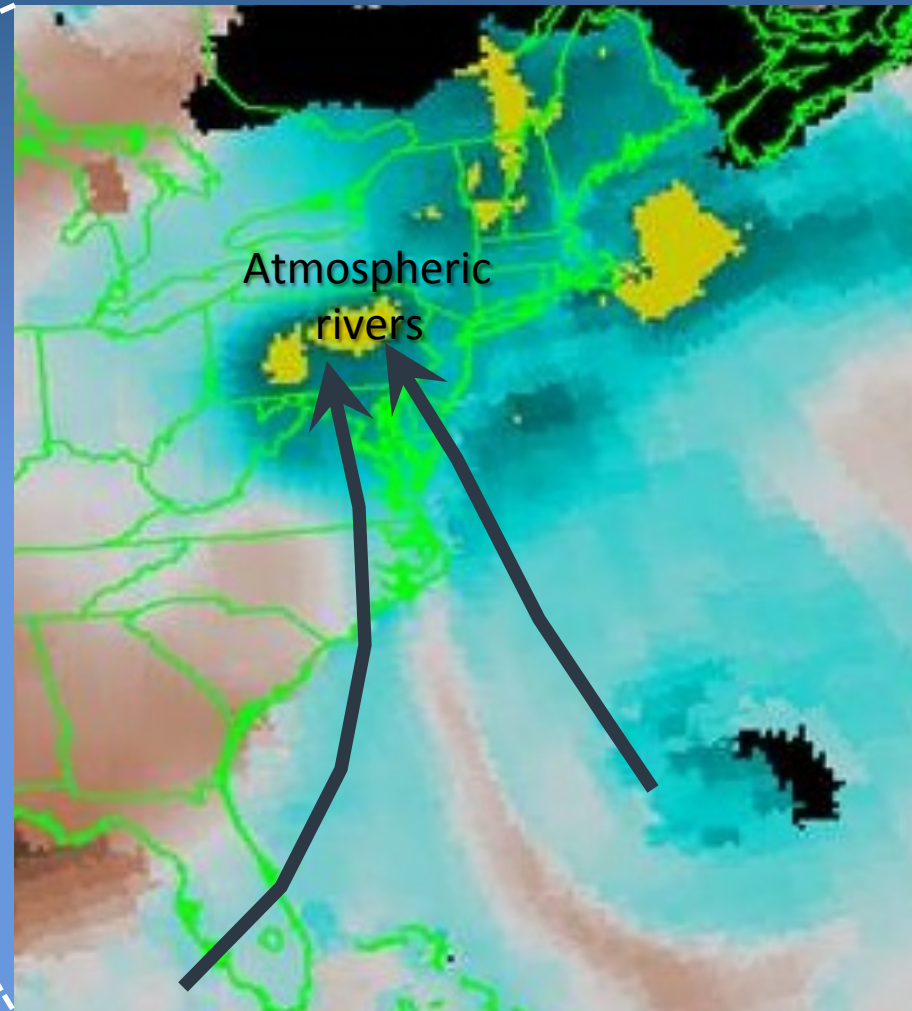
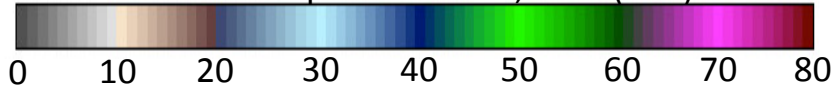
# Synoptic meteorology of Tropical Storm Lee

*a predecessor rain event enhanced by two atmospheric rivers*

September 8, 2011



Total Precipitable Water, TPW (mm)



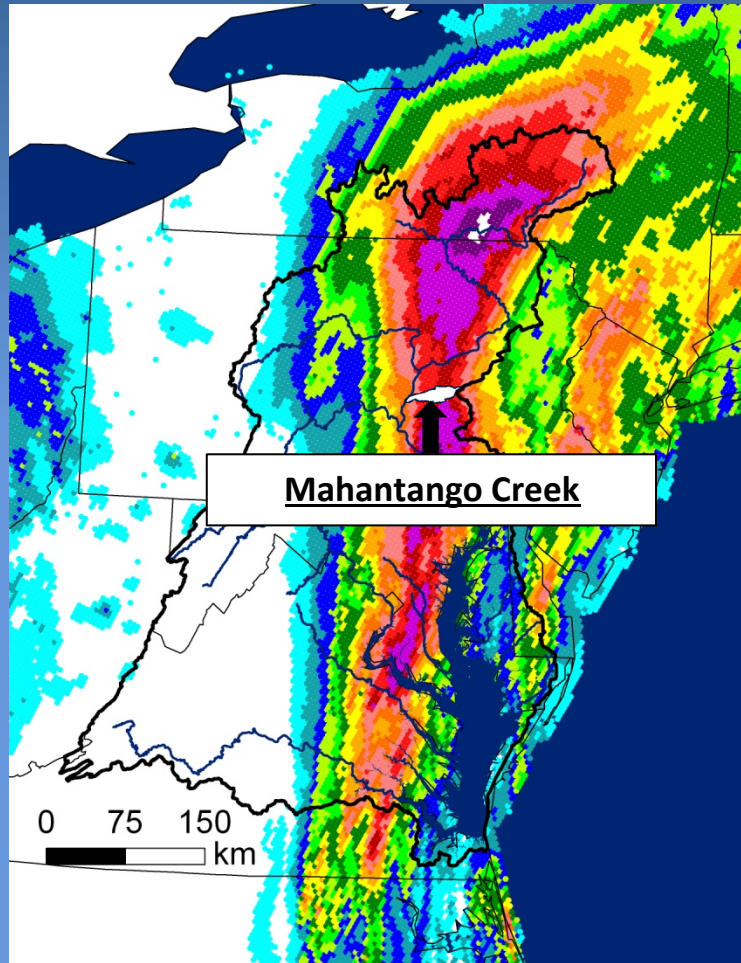
Percent of normal TPW (%)



# Tropical Storm Lee (September 7-8, 2011)

*extreme rains on wet soils yielded 4th highest peak flow since 1968*

## Rainfall (in)



## Storm total rainfall

303 mm in four days

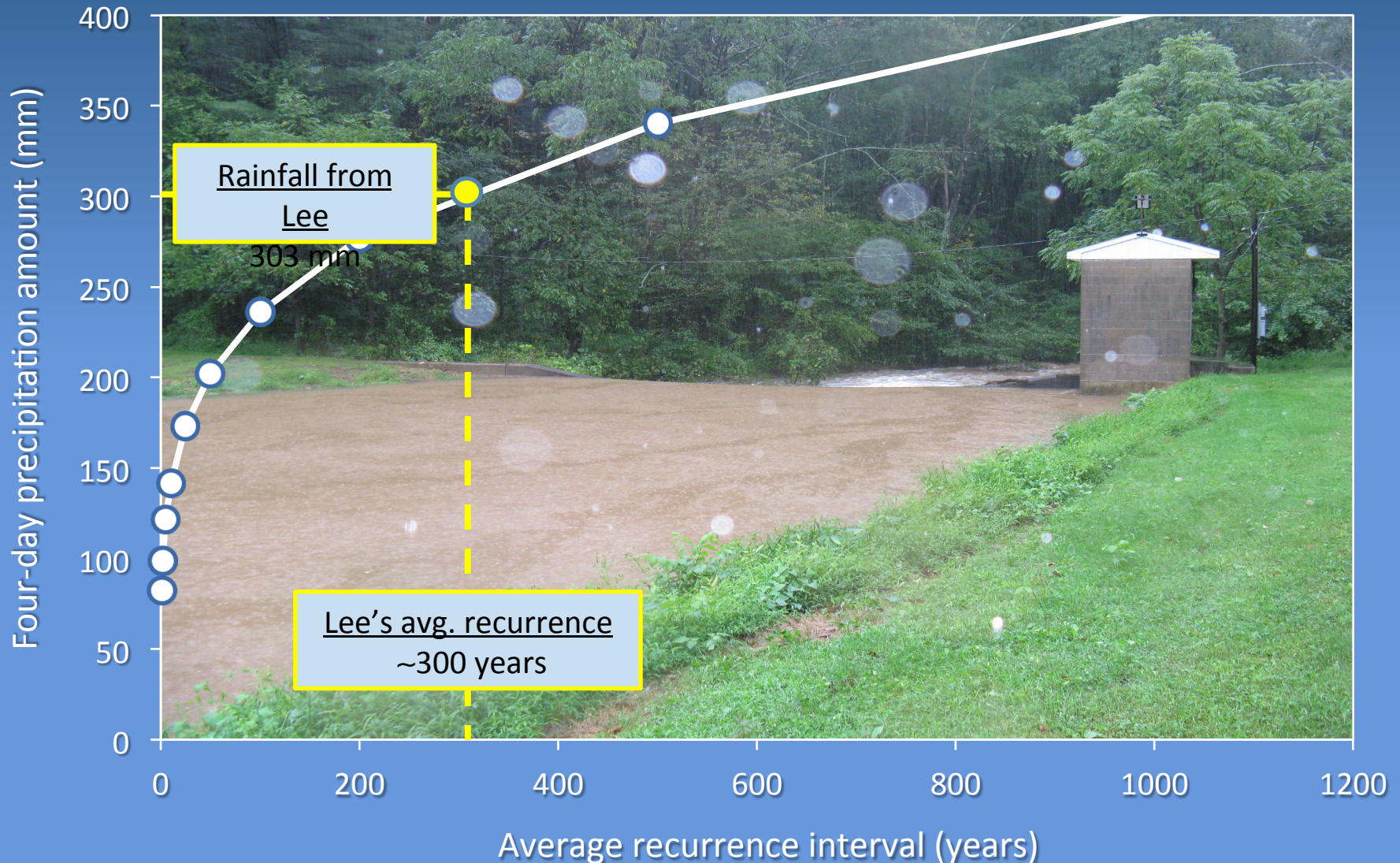
## Peak daily flow

7200 L s<sup>-1</sup>

*\*fourth highest since 1968*

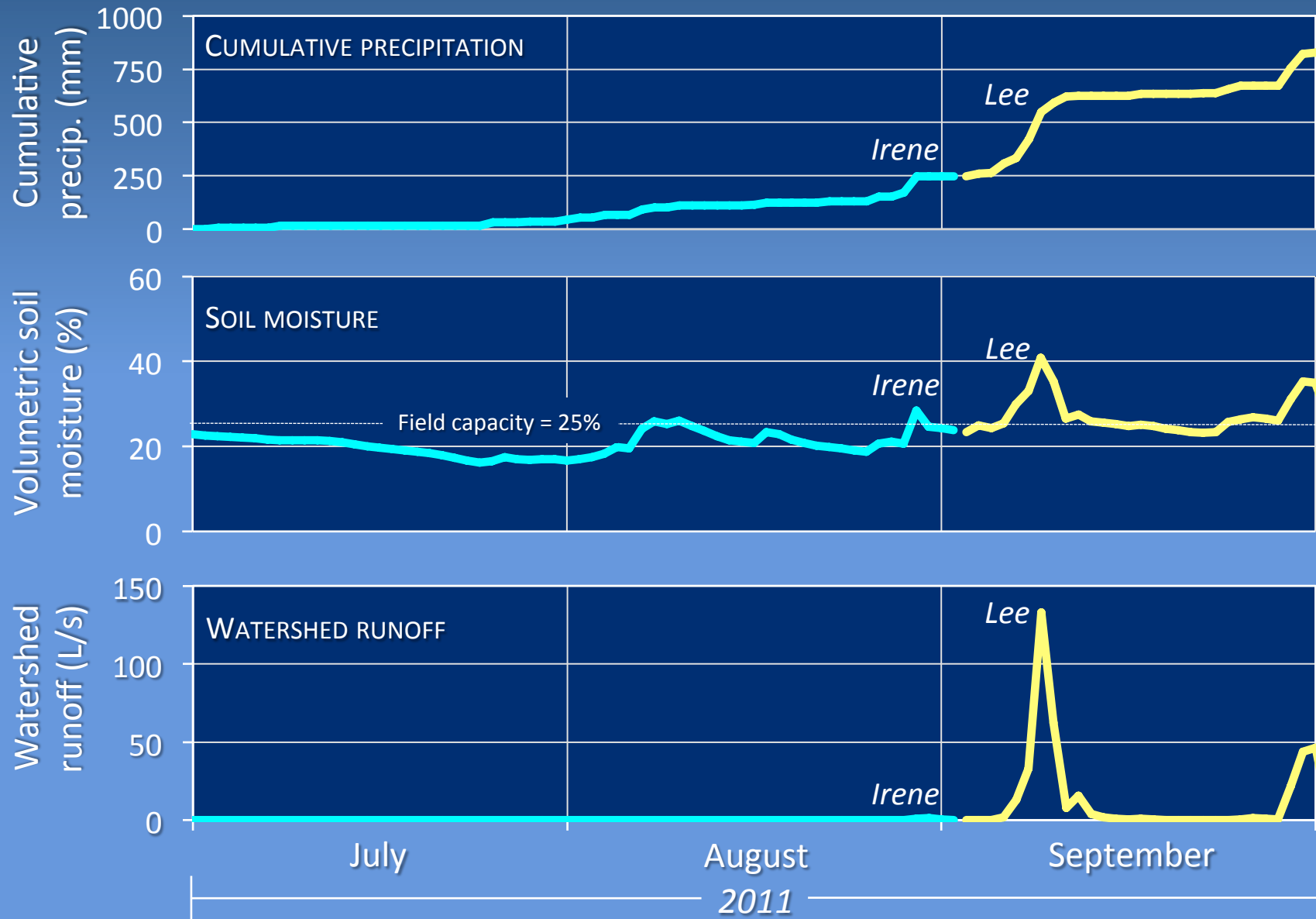
# Tropical Storm Lee's rainfall was extreme

*An average recurrence interval of once every 300 years*



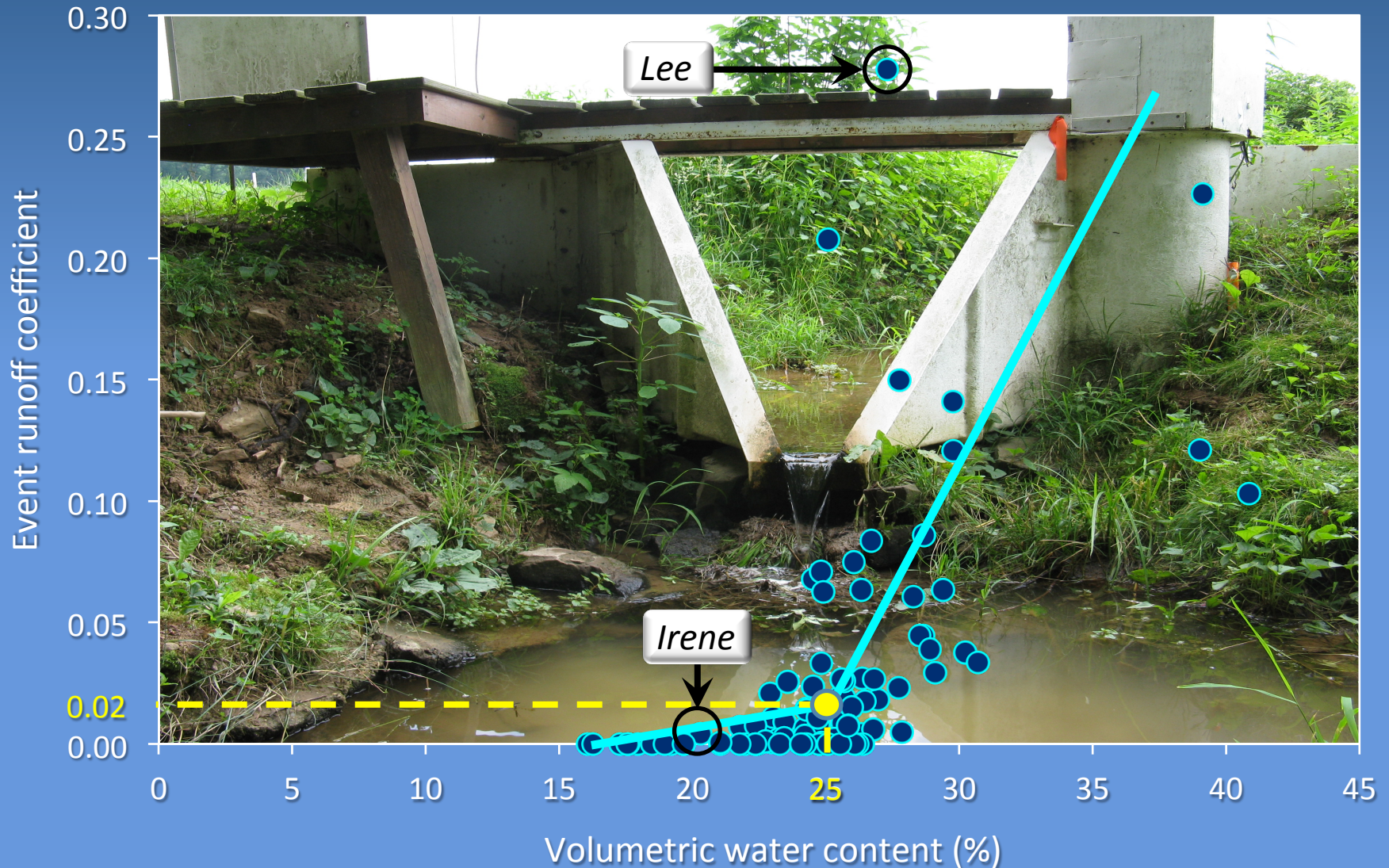
# Hydrologic response from Lee's rainfall

*extreme rains enhanced saturation excess runoff processes*



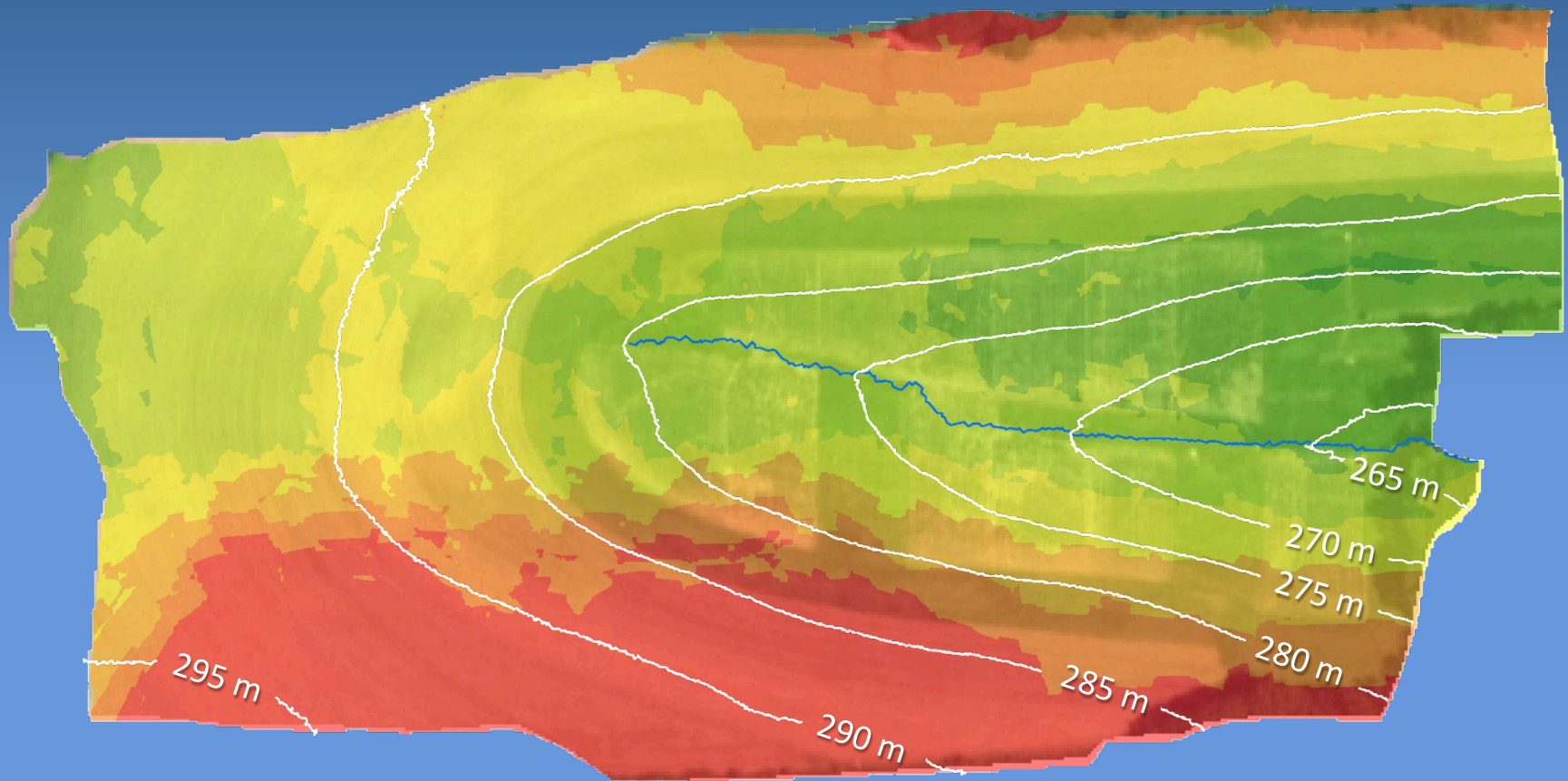
# Extreme rainfall was only half the story

*wet antecedent conditions exacerbated runoff from Lee*



# High P soils represent a P source to runoff

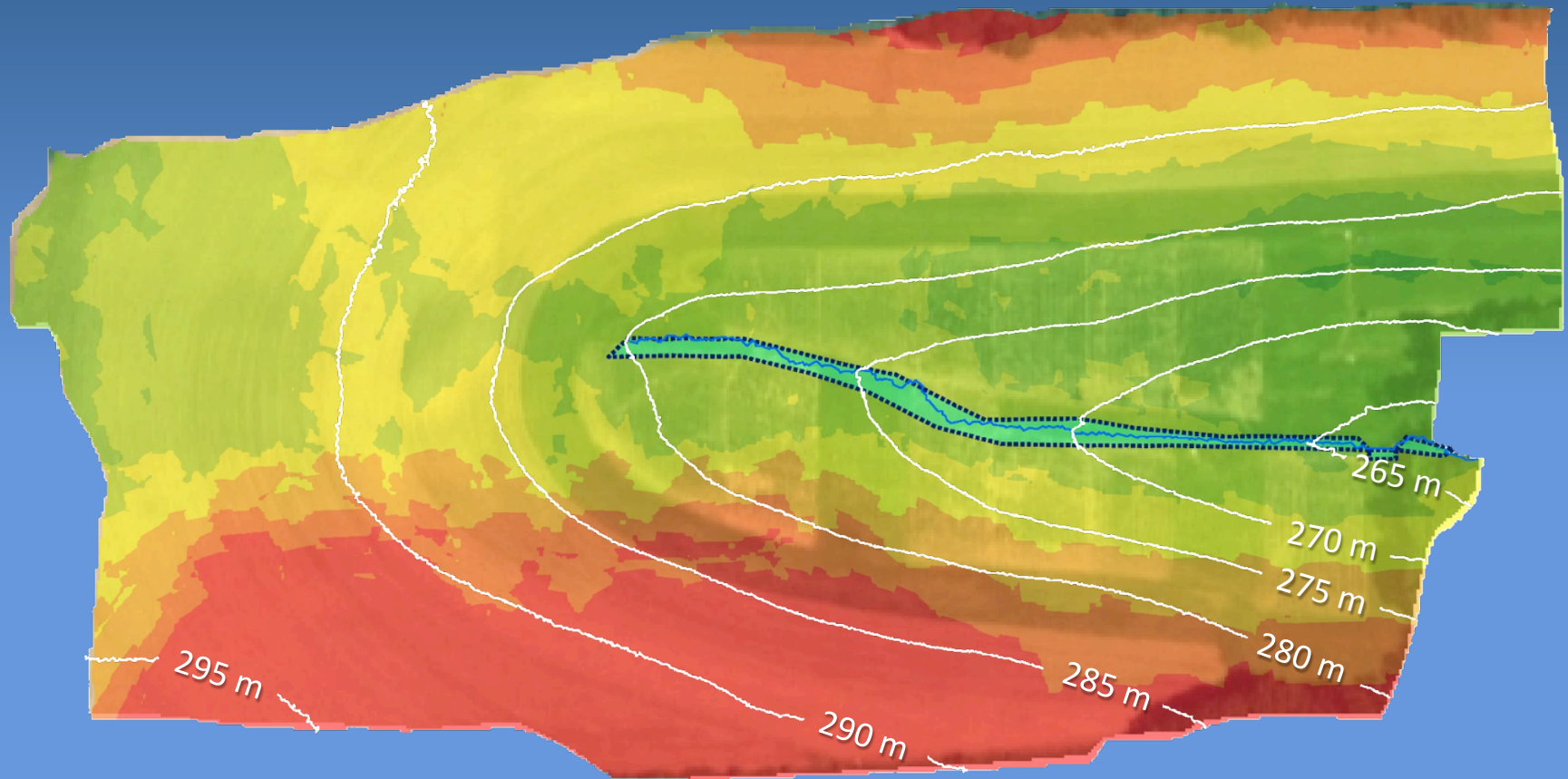
*key factor is the hydrological connectivity with P source areas*



Mehlich-3 soil P (mg/kg)



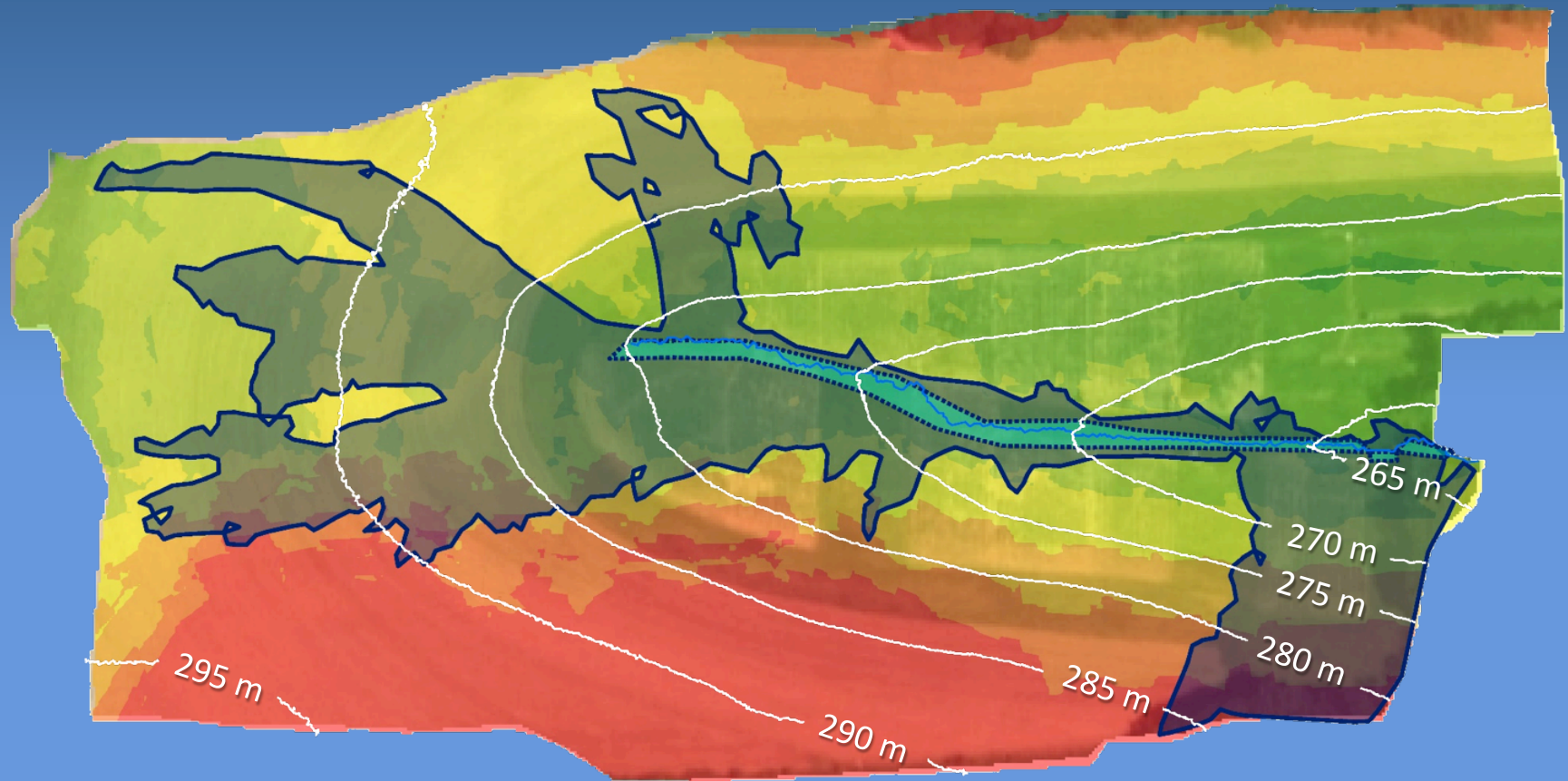
The contributing area for Irene was small  
*only 0.4% of watershed was likely generating runoff and P loss*



Mehlich-3 soil P (mg/kg)



The contributing area for Lee was larger  
*as much as 28% of the watershed generated runoff and P loss*

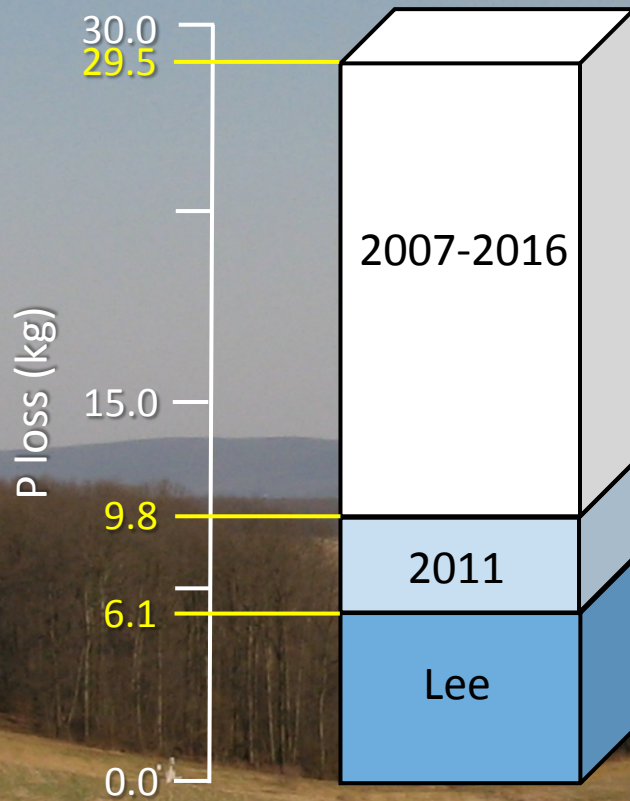


Mehlich-3 soil P (mg/kg)



# P loss from Tropical Storm Lee was profound

*Lee contributed significantly to 2011 and decadal P loss*



Tropical Storm Lee accounted for 21% of the P loss over the past decade.

Tropical Storm Lee accounted for 63% of the P loss in 2011.

# P loss patterns in the Susquehanna

*Annual and decadal P loss trends mirrored those in Mattern*

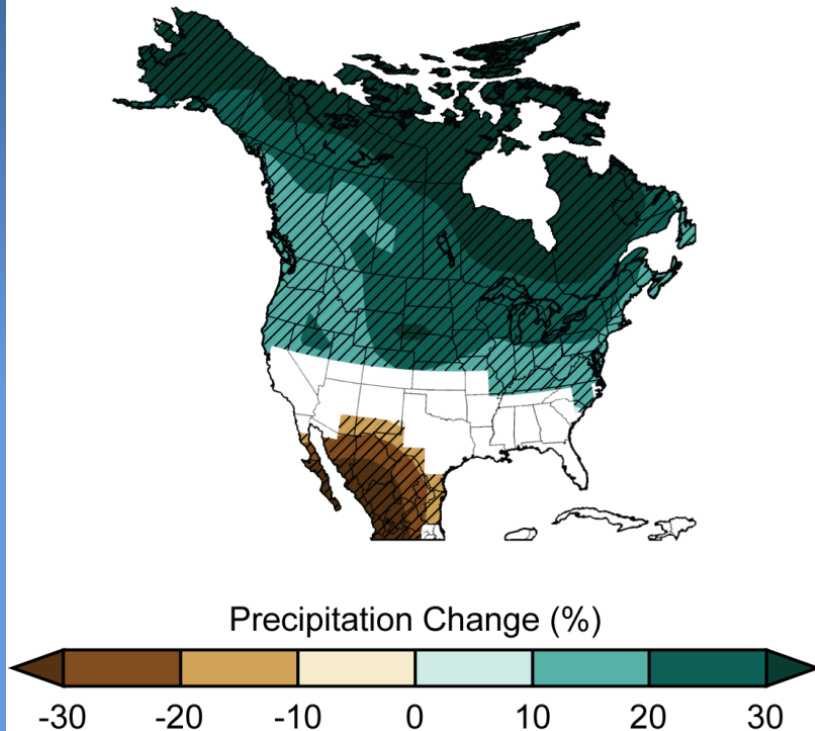


	T.S. Lee as a % of 2011	T.S. Lee as a % of last decade	T.S. Lee as a % of full record
Time	2%	0.2%	0.06%
Flow	12%	1.8%	0.6%
Total Nitrogen	31%	5%	1.8%
Total Phosphorus	61%	22%	9%
Suspended Sediment	78%	39%	22%

# Will we see more Lees in the future?

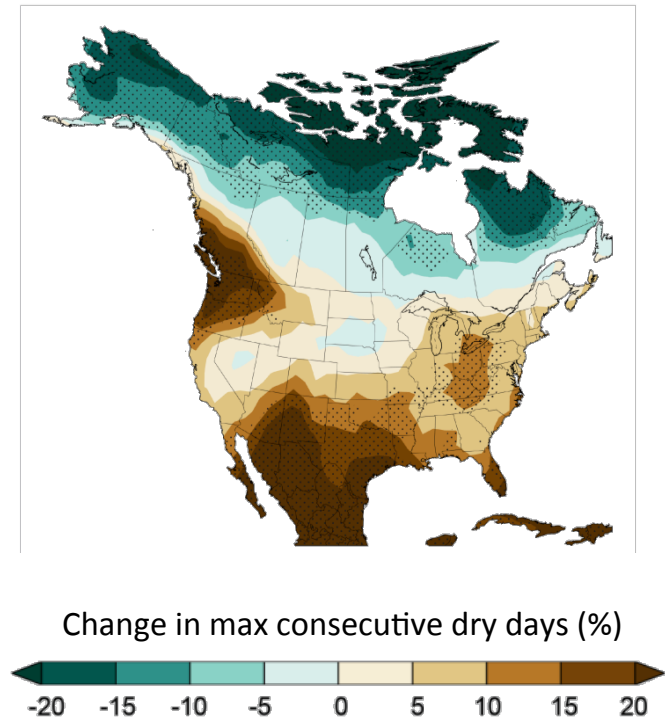
*depends on alignment of basin wetness and extreme rainfall trends*

## Wetter winters



Annual precipitation is likely to increase by 10 to 20%, mainly during the winter season.

## Longer dry spells



More than 80% of climate models suggest that successive dry days will rise by 5 to 10%.

Thank you

*Questions?*

